DESIGNING TREE TOWERS BY APPLYING SECURITY ASPECT TO THE STRUCTURES IN JATIGEDE

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Abstract, Reservoir has a function as a place of supply or reserves of water in a very large amount used for irrigation facilities and hydroelectric power. However, the reservoir can also be used as a tourist attraction. One of them is the Jatigede reservoir located in Sumedang, and one of the tourist attractions there is Peak Damar. The object of Peak Damar, Sumedang Regency has the potential to be developed. However, the potential is still less supported by the ease of access to reach the tourist sites, and not optimal development of tourism objects both facilities and infrastructure. The only tourist attraction available is a view deck that leads directly to Jatigede lake. Though there are pine forests that also have the potential to be developed as tourist attractions, and attractions that look potentially to be developed in the pine forest is a tree tower. The recent tree tower tour becomes a popular type of tourism among the community, along with the development of internet and social media, the tower of the trees serve as a unique and interesting photo spot. Coupled with a beautiful view of nature, of course, the location has its own additional value. To utilize the advantages of the natural scenery around the reservoir, especially in Peak Damar, the designer uses a security aspect based on the science of ergonomics and anthropometry to create an object around the Jatigede dam area which aims as a safe tourist attraction for visitors to use, which will be expected to help the economy of the community around the tourist attraction.

Keywords: Reservoir, Tour, Tree Tower, Security, Visitors, Peak Damar

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1. Preliminary

1.1 Background

Jatigede Reservoir is a reservoir whose construction has been planned since the Dutch East Indies era when the Dutch East Indies government planned to build three reservoirs that will be created along the Cimanuk River, and Jatigede Reservoir is the main and largest reservoir, but due to the many rejection of the citizens around, eventually this project was delayed. According to Airlangga Mardjono, (2014), Jatigede dam construction was re-initiated in 1963 under the government of President Soekarno whose main purpose is to accommodate, add irrigation, and water distribution with design detail in 1988. Land acquisition process for use as a place of dam construction in 1982, which was then connected 20 years later which was a construction process in 2007. Jatigede Reservoir has a main function as irrigation facilities used as fresh water reserves used to irrigate agricultural areas around Majalengka, Indramayu, and Cirebon, and also as a hydroelectric power plant. (Airlangga Mardjono, 2014, detik.com, 12/09/2014)

Apart from the main function, Jatigede Reservoir also has other potential as a place of cultivation facilities for freshwater fisheries, water sports facilities, and as a means of recreation. However, according to local residents living around the reservoir, the situation around Jatigede is considered unstable because the Jatigede reservoir is still in a period of filling the dam causing tidal water that resulted in flood disaster in the event of high tide. Apart from environmental factors, the condition of the people around the reservoir is also very alarming, due to the loss of livelihood and residence caused by the drowning of the village and the surrounding area to be used as a reservoir. On several occasions when conducting field surveys, the authors found many complaints such as lack of provision in livelihoods, lack of clean water, to facilities that did not meet the standard of living.

Behind all the existing turmoil, Jatigede is considered to have tourism potential that can be developed, especially on the potential of nature tourism. There are already several tourist spots that have been made around Jatigede like Cape Duriat, Peak Damar Reservoir Jatigede, Panenjoan Jatigede, and Batu Agung. To design this Peak Damar is the location chosen as a place for the manufacture of tree towers, precisely on a region covered with pine trees that have a cool atmosphere as a tourist, because its position is stategis that is in the highlands so it can see clearly the scenery in around the Jatigede Reservoir.

Tourist attractions contained in Peak Damar at this time only view deck that leads directly to Jatigede Reservoir. Viewed from the side of the security aspects of the four tourist attractions can be practically appropriate. While there are still many spots with good scenery at certain altitudes that can be developed as a tourist attraction, and the security aspects of the design of tourist objects, especially on the structure must be considered due to the many hills and gorges are quite steep in the area around Jatigede. The security aspect especially in structures often plays an important role in determining the various constructions, especially on products directly related to the users.

Therefore, the design of this time the author wants to create a tower tree as a natural tourist attraction by utilizing the area of Jatigede dam or other areas with the same potential. In the design of tree towers there are several aspects including ergonomic aspects, visual aspects, aspects of structural security, material aspects, and maintenance aspects. But the focus of the author's discussion on design is the security aspect of the structure with anthropometric scholarship devoted to the percentiles of Indonesians and Asians, as supporters aiming to create a safe tree tower design when used by visitors. Discussion on the security aspects of the structure will be divided into several discussion points, including: the security aspects of the structure on the design, security, and anthropometry of users. Based on these points, it is hoped that the goal of tree tower design will be achieved by making the security aspect of the structure as the focus of discussion on the design of the tree tower, and making the tower of the tree as a natural tourist attraction that is safe for visitors.

1.1 Purpose

There is two purpose, the general purpose is to make the tower as a natural tourist attraction that safe for visitor and making security aspects of the structure as the focus of discussion on the design of tree towers. Special Purpose is to designing tree towers by observing the security aspect based on anthropometry science and of course to qualify for a Bachelor Degree in Product Design of Telkom University.

2. Theoretical Basis

2.1 Security

Understanding Security is a state free of physical and psychological injury or it could be a safe and secure state (Potter & Perry, 2006). A change of comfort is a state in which the individual experiences unpleasant sensations and responds to a dangerous stimulus (Carpenito & Sell, 2000).

The need for safety or security is the need to protect yourself from physical harm. Threats to a

person's safety can be categorized as mechanical, chemical and bacteriological threats. Ignorance of something sometimes creates anxiety and insecurity. (Asmadi, 2005).

2.2 Structure

According to Shcodek (1998), the structure is defined as a means to channel the load and the consequences of its use and or the presence of buildings into the ground. As for other opinions regarding the definition of structure according to R. C. Hibbeler (2012), Structure refers to the system of connected components used to support the load.

The design of structures can be identified as a mixture of art and science combined with the intuition of a structural expert on the behavior of structures with basic knowledge in statics, dynamics, mechanics, materials, and structural analysis, to produce a structure that is economically and securely (Agus Setiawan, 2013)

2.2.1 Type of Structure

There are 4 types of platform structure designs that can be applied to the sprawling tower of trees, among which are:

1. The platform structure with 1 tree
2. Platform with 2 trees
3. Platform with 3 trees
4. Platform with 4 trees

2.2.2 Load

1. Dead Load

Dead load is the burden of all parts of a building building that is fixed during the service life of the structure.

2. Live Load

The live load is the gravitational load that works on the structure in its lifetime, and arises from the use of a building. Included in this burden are human weight, removable furniture, vehicles, and other items.

3. Wind Load

Wind load is a load that works on structures due to pressure from wind movement. The wind load is highly dependent on the location and height of the structure. The magnitude of the inflatable pressure shall be taken at a minimum of 25kg / m2, except for the following buildings:

1) The inflatable pressure at the seaside up to 5km from the shore should be taken minimum 40kg / m2.

2) For buildings in other areas where the probability of inflatable pressure is more than 40kg / m2, it should be taken at p = V2 / 16, where V is the wind speed in m / s.

4. Earthquake Load

Earthquake loads are all static equivalent loads acting on the structure due to earth movement by earthquakes, either vertical or horizontal. However, in general the acceleration of the horizontal dirt direction is greater than the vertical direction.

2.2.3 Connection

1. Connection Bolts

Each steel structure is a composite of several rod components incorporated with a fastening device. One of the welding tools other than the weld is a bolt. at the bolt junction there are several factors affecting the strength of the joints on the strata, such as the quality of the bolt, the nominal resistance of the bolt, the connection type based on the shear and pull load.

2. Weld connections

In the welded joint, there is a process of grafting the metal material which produces the melting of the material by heating the material to the right temperature or without pressure and with or without the use of the filler. There are several types of connections on welding techniques, including:

1) Field connection
2) Connection passes
3) Upright connection
4) Angular connections
5) Side connection

3. Wooden Connections

Wooden connections are two or more logs connected to each other by using a lock to become a structure on a building construction. There are several types of connections on the structure with wood material, including:

1) Connection with straight type wood lip
2) Connection with straight pull type wood
3) Connection with lopsided type of wood
4) Connection with straight linked straight-lined wood
5) Angled connection
6) The connection widened
7) Longitudinal connections, etc.

2.3 Tree Tower

According to Great Dictionary of Bahasa Indonesia, the tree is a hard and large trunked plant while the tower is a high building to supervise the

surrounding area. Based on these two conclusions can be concluded that the tower of a tree is a building located above the tree used to see the circumstances around from a height. There are two types of tree towers, which are tree towers built directly on trees and tree towers built with a foundation structure or called freestanding.

Quoted from thetreehouseguide.com (2016), there are several criteria for selecting the right tree, including:

1. Stems and branches of strong and strong trees.
2. The root is deep and strong.
3. No sign of parasite or disease that can weaken the tree.
4. Tree that is not old, dead, young.
5. The minimum diameter of the tree is 8 inches or about 20cm.

Based on the above criteria, it can be concluded that the tree that can be used as the foundation for making safe tree towers is a tree species with stems, tree branches, and strong roots. Below are some types of trees that grow in Indonesia are often used as a foundation of trees in tourist attractions, including:

1) Fir tree
2) Pine Tree

3. Design Analysis

3.1 Aspect of Design

In this design there are several aspect of design that are used, among other aspect if primary, secondary, and tertiary. Here are some categories of analysis and weighting based on the needs of the design.

Table 3.1 Desing Needs

No.	Aspek	Kebutuhan Aspek						
		Struktur	Keamanan	Pengguna	Ergonomi	Material	Lingkungan	Estetika
1.	Aktivitas	✓	✓	✓	✓		✓	
2.	Fungsi	✓	✓	✓	✓	✓	✓	
3.	Produksi					✓		
4.	Visual					✓		✓

(source:author data, 2018)

3.2 Primary Aspect Analysis

3.2.1 Structure

In addition to load counting, another factor that affects security in the design of a tree tower is the structure of the tree tower itself and the system at its junction. Before determining what structure will be made, the first thing to do is the state of the environment especially the condition
and type of soil which will be used as the location of the structure.

Land conditions that are not supportive for development will inhibit and can cause problems such as structures that collapse due to land that can not withstand the weight of the structure that will indirectly threaten the safety of visitors.

3.2.2 Installation Mechanism

Aspects of the mounting mechanism are aspects that explain the type of keying system and support for building tower structures on trees. In the design of tree towers there are three types of systems used, including the post system, bracket system and post / pole system.

3.2.3 Load

In load analysis, the main focus of the discussion is the type of load contained in such structures, dead load, live load, and wind load. The load calculation is closely related to the safety of the user while climbing the tree tower, in case of errors in the load calculation it will have a direct impact on the structure and shape of the tree tower to be created. Below will be described on the types of the load.

1. Dead Load

The dead load is a load coming from all parts of a fixed structure during the lifetime of the structure, below is a table containing the material load used for the design of a tree tower.

Table 3.2 Load on the Material

No	Material	Berat
1	Steel	7850 kg/m^3
2	Wood (class1)	1000 kg/m^3

(source:Building Regulations, 1983)

2. Live Load

It is a burden whose position is subject to change. Load who can move with his own strength is called moving loads, such as vehicles, people, and cranes. In this design the live load that works on the structure is human. Humans have different body loads - depending on the height. Then below is a table of live load on the floor of the building with the type of balcony, including room equipment in accordance with the usefulness and needs (q (approx) 100 kg / m3) (see table 3.6)

Table 3.3 Live Weight on Balcony Type Building

f	The floors and balconies in the rooms for meetings other than those mentioned in a s / d e, such as mosques, churches, showrooms, meeting rooms, cinemas, and audience stage	400	Kg/m^2
m	The balconies are jutting freely out (must be planned against live load from the adjacent room floor, with a minimum)	300	Kg/m^2

(source:Building Regulations, 1983)

Based on the above table the tree tower belongs to the category m which is a free jutting out balcony, so the minimal living load on the tree tower is 300 kg / m2. Meanwhile, to calculate the maximum load on the tree tower using the formula that is:

Maximum load (qu) = *1,2.qd + 1,6.ql*

(description: qd (dead load), ql (live load)

Qd is a dead load, is a load derived from two steel and wood materials, then the load will be combined because it is in one structure.

Bb + Bk = Jb

$7850 + 1000 = 8850\ kg/m^3$

(description: Bb (steel weight), Bk (heavy wood), Jb (Total weight)

So to calculate the maximum load on the structure using the formula above is as follows:

Maximum load (qu) = 1,2.8850 + 1,6.300

= 10.620 + 480

$= 11.100\ kg/m^2$

Then if the structure and platform use only wood material only, then the maximum load is:

Maximum load (qu) = 1,2.1000 + 1,6.300

= 1200 + 480

$= 1.680\ kg/m^2$

Then there is also a load that works on the structure caused by the gravity of the earth that works on an object, the load is gravity. How to calculate gravity are:

W = m x g

(description: w (gravity (N), m (mass of body (kg), g (earth's gravity (m / s2)

It is known that the mass of the body in the structure is 8850kg and the gravitational force on earth is 9.8m / s2. Then the gravity acting on the structure is:

W = 8850 x 9.8

= 86.730 N/kg

3. Wind Load

Wind load is the load generated by the pressure of wind movement acting on the structure. The wind movement around the pine forest at Peak Damar is 24km / h - 35km / h, while the minimum inflatable pressure is 25 kg / m2. The formula for calculating the wind load is: F = A x P x Cd, F is the force or wind load, A is the projected area of the object, P is the wind pressure, and Dc is the coefficient of resistance. And the wind load for 1st floor and 2nd floor are: wind load with 24km/h wind pressure (1st floor = 5.8kg, 2nd floor = 8.7kg), wind load with 35km/h wind pressure (1st floor = 8.5kg, 2nd floor = 12.8kg)

3.3 Secondary Aspect Analysis

3.3.1 Material

The discussion of the material aspect contains an explanation of what kind of material is suitable for use to create a tree tower. In this design the material used is the material of metal / steel and wood, below is the exposure of the nature of the material used.

1. Metal steel

Then there is a steel material often used in construction classified into 3 types, namely:

1) Carbon steel
2) High quality low alloy steel
3) Steel alloy

2. Wood

Wood is a natural material that requires processing before it can be used. Its ease to be processed makes wood as a material often used in everyday life, whether for furniture, building structures, household appliances, and so forth, the most suitable material used in this design is with wood material used on platform, railing and stairs due to the availability and ease of material to be obtained and more easily in the workmanship and installation.

3.3.2 Ergonomics

Aspects of ergonomics contains discussion of circulation analysis of the user by determining the capacity of visitors on the tree tower so that visitors feel safe and comfortable when doing the activity. Below is the data on the circulation zones of visitors that will be used to determine the capacity of users.

1. Adult visitors have a circular zone size of 183cm

2. Children Visitors have a circulation zone size of 159.4cm
3. Visitors holding a small child have a circulation zone of 201cm
4. Visitors carrying bags have a circulation zone of 183cm

It can be concluded based on the above calculation that the maximum capacity for adult is 9 people (bottom platform) and 7 people (upper platform), for children as many as 11 people (bottom platform) and 8 people (upper platform), for adults with children - children 9 people (bottom platform) and 6 people (upper platform), for adults with bags of 9 people (bottom platform) and 7 people (top platform), for a combination of visitors are as many as 10 people (bottom platform) and 7 people (top platform), and the overall visitor load by using the 95% percentile is 1.984kg.

3.3.3 User

In user analysis obtained from field data that is observation and study of literature to user safety.

1. User Security

To support the user's comfort when doing activities in the tree tower, then one aspect that must be considered is the security on the user. Because of the position of the tower of trees that are in altitude, the possibility of accidents is very possible if the security system on the tree tower is less good or due to negligence of the user itself. Possible accidents that can occur in this case are two types, namely falling from the platform and slip when climbing the ladder or slip when it is above the platform. To prevent this, the designer makes safety in the form of handrail and flooring with non-slippery material.

3.6 T.O.R (Term of Reference)

3.6.1 Design Considerations

These considerations are some things that must be considered in the design so that the resulting design in accordance with the purpose. Here are the design considerations, including:

1. Structure Type
   The considerations on structural aspects are as follows:

   1) The structure adjusts to the state of the location.
   2) The shape of the structure should not inhibit tree growth / wounding trees.
   3) The shape of the structure and its joints must be sturdy so that it is safe when used.

2. Locking System
   Considerations on the lock system aspects of tree towers are as follows:

   1) Locking must be precise so as not to hurt the tree.
   2) The locking system must be firmly installed so that the structure does not collapse.

3. Load
   The following are considerations in this aspect.

   1) The work load on the product should not exceed the maximum load on the tree tower.
   2) Working wind loads may change depending on the weather
   3) Determining the limit of the number of users so that there is no overweight or inconvenience due to the users who are too crowded.

4. Material
   The use of materials in a planning is an important aspect, here are the considerations on the material aspects:

   1) The material used must be strong against weather or chemical processes that occur during the lifetime of the product.
   2) The amount of material availability is easy to obtain.
   3) Ease of material to be handled and worked on.

5. Ergonomics
   Considerations on aspects of ergonomics include:

   1) The user capacity of tree towers should be adjusted to the area of the platform and the circulation zone
   2) Capacity should not exceed the calculation result.

6. Security
   What should be considered in this aspect are:

   1) Security system that corresponds to the user's body dimension.
   2) The security system should not interfere with user activities.

1.6.2 Limits

The limitation of the problems contained in this design are:

1. Tree towers intended only for tourist attractions.
2. Tree towers are intended for the general public.
3. The material used is wood and steel.
4. Size and height of the platform adjust the environmental conditions and tree diameter.
5. Visitor Capacity is 9 people (bottom platform) and 7 people (upper platform) for adult, 11 people (bottom platform) and 8 people (upper platform) for children, 9 people (bottom platform) and 6 people (upper platform) for adult with children, 9 people (bottom platform) and 7 people (upper platform) for adult with bags, and 10 people (bottom platform) and 7 people (upper platform) for a mix of all four categories of visitors, with total weight of 1.984 kg.
6. The maximum load that can be supported by structures whit steel and wood material is 11.100kg/m^2, the maximum load of structures with wood material is 1.680 kg/m2, while the gravity acting on the structure is 86.730 N/kg.

1.6.3 Product Description

This product is a tree tower that functioned as a recreational place for the community located around Jatigede Reservoir, Sumedang, precisely in Peak Damar. With 4.5x4 meter size on the lower platform and 4.5x3 meters on the upper platform with height 2 meters for the bottom and 4 meters for the top, maximum load up to 11.100 kg/m2 and user capacity divided to four different categories that have been explained in limits section.

CONCLUSION

The design of this tree tower is designated as a natural-based tourism that can be applied in other location that have the same potential. The suggerstions given for the development of design in the next design is the additional of lighting sources on the tree tower and the addition of public facilities such as bench and trash can so that user can feel comfortable when in the tree tower.

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